

TOTAL TRIHALOMETHANES IN DRINKING WATER AND LOW BIRTH WEIGHT

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Scientific Purpose in Linking Birth Outcomes and DBPs in Drinking Water

- ❑ Several epidemiological studies have shown increased risk of impaired fetal growth associated with exposures to disinfection byproducts (e.g., Bove et al. 1995, 2002 ; Infante-Rivard 2004; Savitz et al. 2005)
- ❑ Third trimester of pregnancy: time during which fetal growth and birth weight may be most sensitive to environmental exposure opportunities (Kline et al. 1989)

II. Variables Available for Linkage

- ☐ Environmental Data
 - Water Quality Data

- ☐ Health Data
 - Low Birth Weight Data

Linkage Variables - Environmental Data

- ❑ Drinking water quality data from municipal water supplies are housed in Massachusetts Department of Environmental Protection Water Quality System database
- ❑ Water quality data from approximately 1988-present are computerized, with most complete data beginning in 1993 for public water supply (PWS) systems
- ❑ This linkage project focused on total trihalomethane (TTHM) data

Linkage Variables - Health

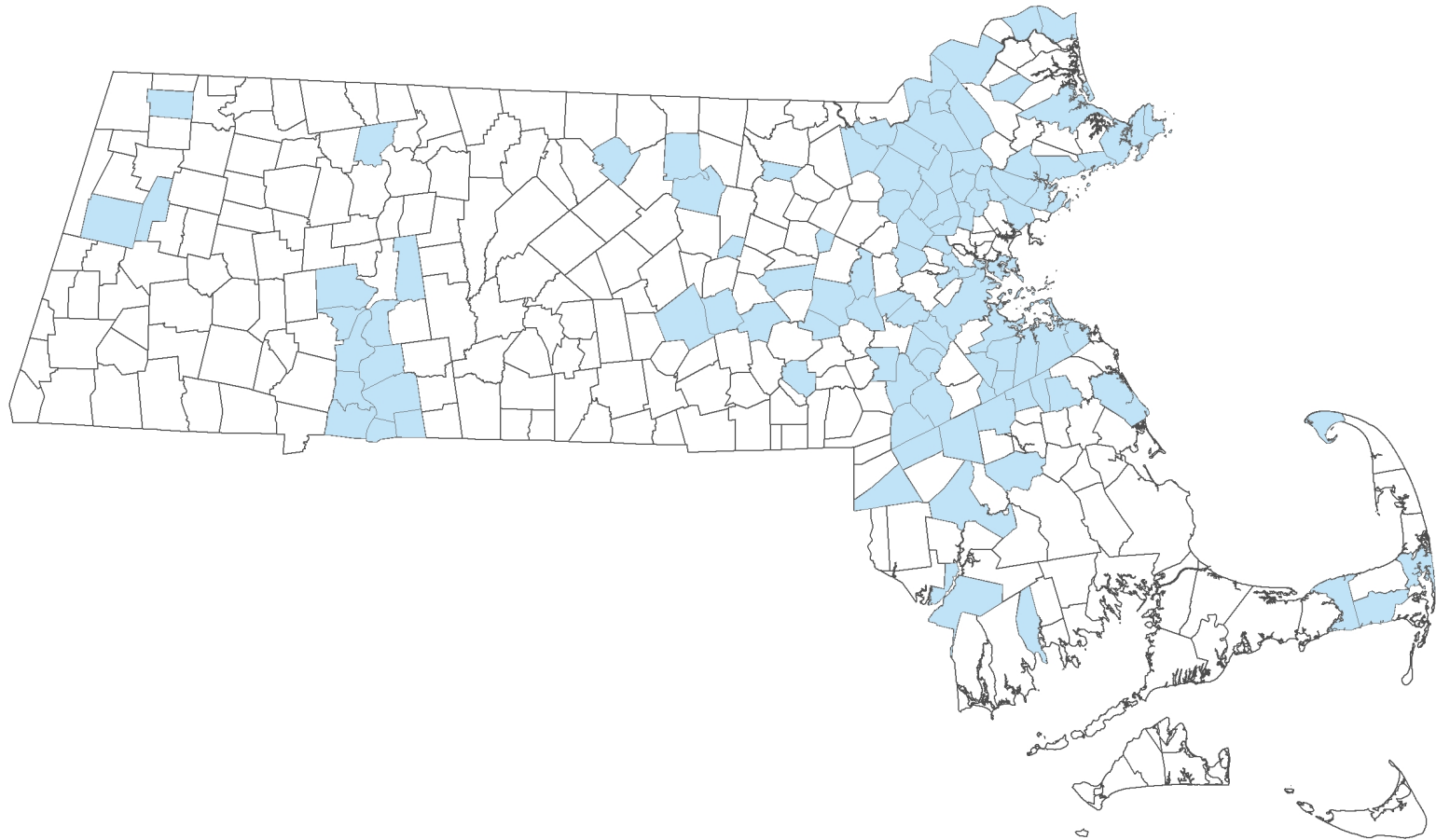
- ❑ Low birth weight data obtained from Massachusetts Registry of Vital Records and Statistics, housed in the Massachusetts Department of Public Health
- ❑ Collect information on nearly 80,000 annual births in Massachusetts
- ❑ Computerized since 1969 and available in Access database

Environmental Data


Water Quality Data

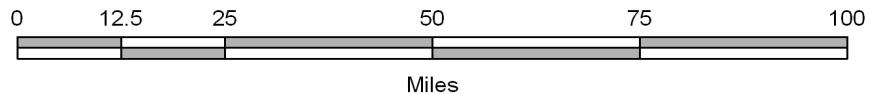
- ❑ Obtained TTHM data for all Massachusetts Public Water Supply (PWS) systems: a total of 241 PWS in the state serve more than 3,300 customers
- ❑ Of the 241 PWS systems statewide, 134 PWS systems serve at least 95 percent of an entire community covering 137 Massachusetts communities (some PWS serve more than one community)
- ❑ Of the 134 PWS systems serving at least 95 percent of an entire community, 123 PWS systems chlorinate their drinking water
- ❑ Linkage analyses thus focused on these 123 communities given confidence that nearly all residents received chlorinated water from their respective PWS

Selected Cities and Towns, Commonwealth of Massachusetts.



Legend

 Selected Cities & Towns

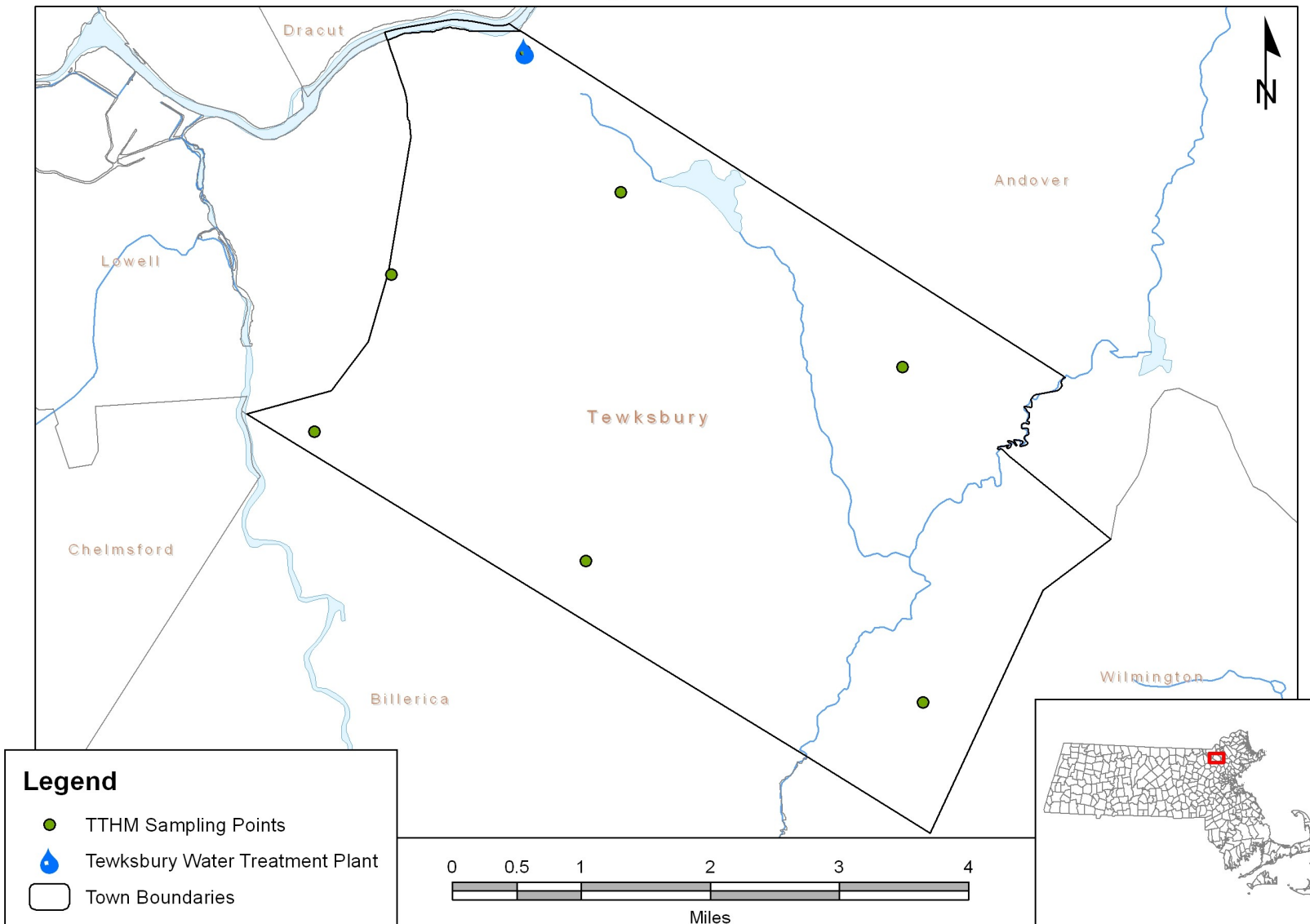


Environmental Data

Water Quality Data

- ☐ Chlorinating PWS systems serving 3,300 or more have more stringent requirements for TTHM testing and hence significantly more data available for these systems
- ☐ TTHMs are required to be measured on a quarterly basis from monitoring locations throughout the PWS distribution area (usually within town boundaries)
- ☐ In general, TTHM concentration may vary by season and as the distance from the treatment plant increases (e.g., in one community, mean TTHM at location nearest treatment plant was 13.7 ppb over six-year period, while mean TTHM at location farthest from plant was 55.5 ppb)

TTHM Sampling Locations, Tewksbury, Massachusetts.



Health Data

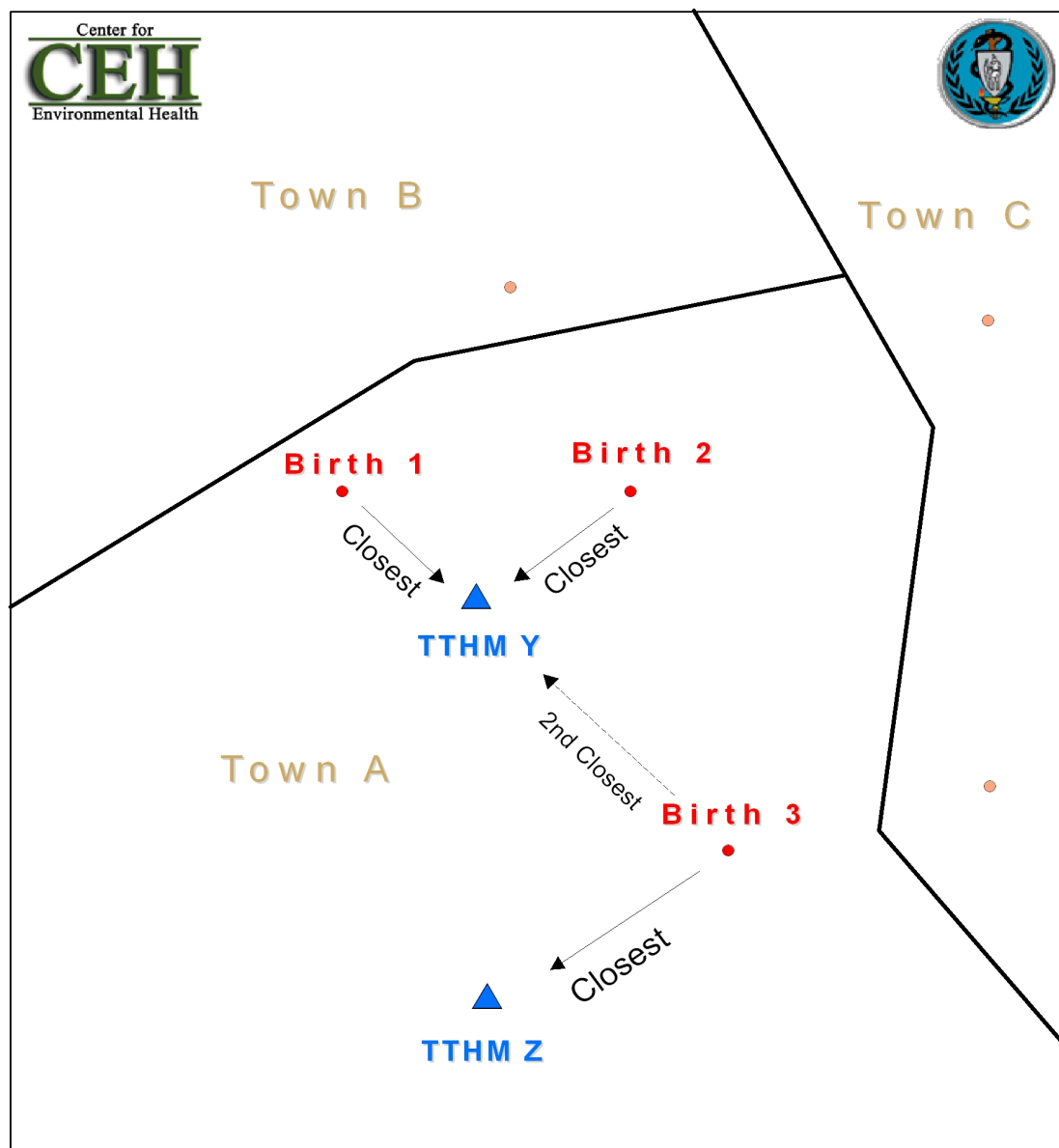
Low birth weight data

- ☐ Low birth weight defined as infant weight of less than 2,500 grams at birth
- ☐ Key variables readily available include date of birth, maternal address at birth, birth weight, gender, some maternal risk factor information (e.g., smoking status)

III. Linkage Goals

Assess low birth weight data in relation to nearest TTHM sampling location in community for possible relationships (i.e., greater occurrence of low birth weight babies in areas with higher TTHM levels)

- ☐ Assign each live birth to nearest TTHM sampling location based on maternal address at birth
- ☐ Assign TTHM level corresponding to the last trimester of pregnancy for each live birth
- ☐ Calculate total low birth weight odds ratios according to TTHM exposure categories (≤ 40 ppb, $>40-80$ ppb, >80 ppb) across all communities



TTHM sampling locations and all births (2001 - 2003) were geocoded. Using GIS tools the nearest TTHM sampling location within the given town was determined for each birth.

The TTHM value from that sampling location for the third trimester of the pregnancy was then assigned to the given birth.

If no TTHM samples were taken in the appropriate time frame the next closest TTHM sampling point was checked, and so on.



Town Boundaries



TTHM Sampling Locations



Births

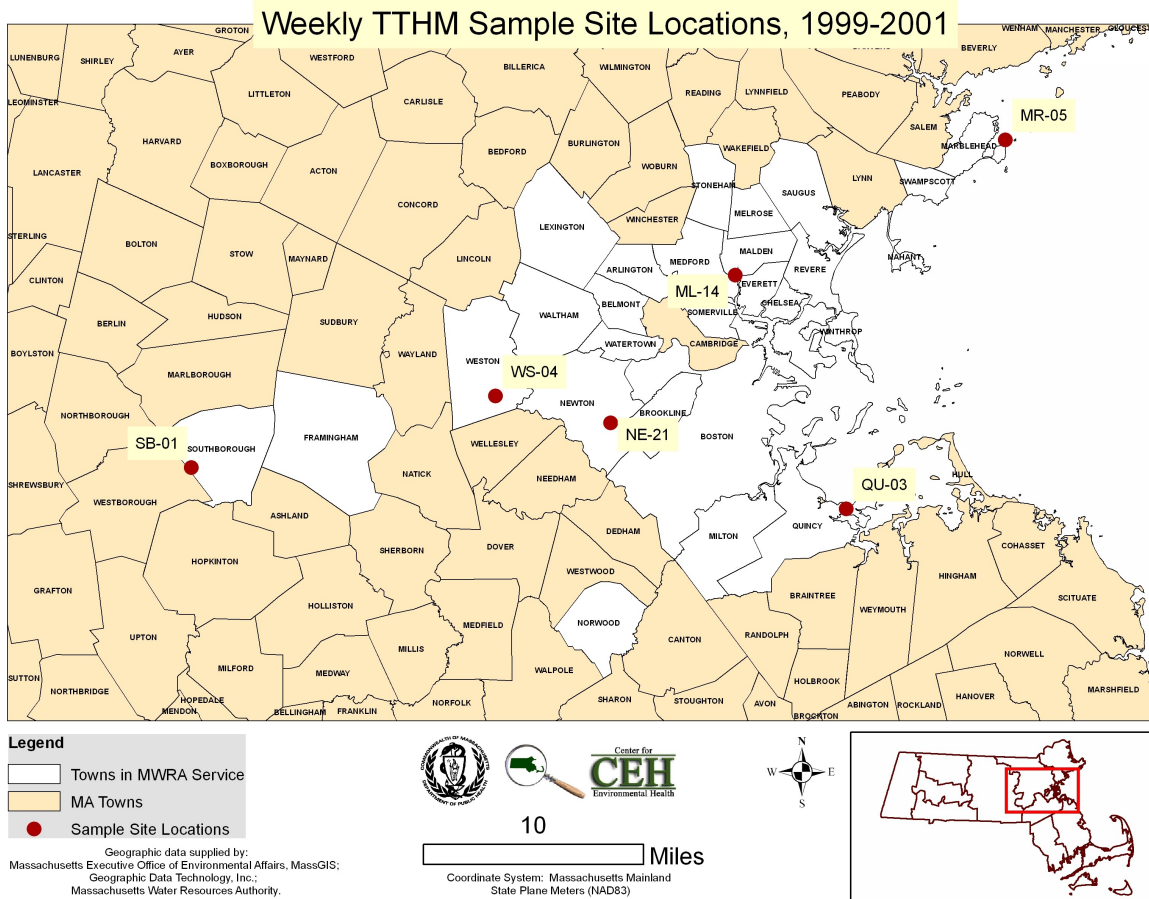
****All data fabricated for purpose of example****

IV. Analyses for Greater Boston Area

Linkage Analyses for Greater Boston Area

- Communities served by the Massachusetts Water Resources Authority (MWRA), improves exposure assessment by relying on weekly, rather than quarterly, monitoring data (1999-2001). In addition, the water treatment regimens employed by the treatment system studies minimize the geographic variability of TTHMs
- In addition to third trimester risk estimates typically derived in such studies, first and second trimester estimates were also calculated

Weekly TTHM Sample Site Locations



MWRA
supplies full
water service
to 27
communities in
the Boston
Metropolitan
area.

Birth Data

Birth records were obtained from the Registry of Vital Records and Statistics, MDPH for those conceived February 1999 – February 2001 and born August 1999 – December 2001, whose maternal residence at time of birth was one of the 27 MWRA communities

V. Results for Greater Boston

Term Low Birth Weight & Exposure

Unadjusted Odds Ratios

(all races N=780)

Exposure	1 st Trimester	2 nd Trimester	3 rd Trimester
< 40	1.00	1.00	1.00
40 to <50	0.87 (0.72, 1.05)	1.04 (0.84, 1.29)	1.05 (0.79, 1.39)
50 to <60	0.90 (0.73, 1.11)	1.12 (0.92, 1.49)	0.84 (0.63, 1.11)
60 to 70+	0.92 (0.73, 1.15)	1.17 (0.92, 1.49)	0.89 (0.66, 1.19)
70+	0.87 (0.67, 1.13)	1.31 (1.06, 1.66)	0.96 (0.70, 1.32)

Results

- To account for the potential impact of geographic variation in TTHM, a crude sensitivity analysis was conducted
- Using existing exposure values assigned to each mother, the values were weighted on the basis of TTHM data from a single sampling site closest to the mother's residence
- This analysis raised the possibility that some unaccounted for geographic variation in TTHM data could lead to different exposure results and thus different overall results
- Using logistic regression and adjusting for potential confounding factors, a statistically significant risk for term low birth weight was found among those with high (70+ ppb) TTHM exposure, notably Hispanic women.

VI. Lessons Learned & Next Steps

Lessons Learned

Environmental Data

- ❑ About 40 percent of Massachusetts chlorinating public water supply systems serve less than 95 percent of the community in which it is located; thus, for those communities, it is difficult to determine which residents receive chlorinated public drinking versus other sources (e.g., private well water) and hence more work should be done to better define the geographic extent of each PWS service area
- ❑ TTHM sampling locations may change within a community from year to year, presenting challenges in readily assigning exposures to the health variable for linkage
- ❑ Regulatory databases require significant manipulation, research, and customization for EPHT linkage

Lessons Learned

Health Data

- ❑ Use of different reference data for geocoding between different data sets can result in some geocoded data not matching well for linkage; prior decisions on reference data for geocoding could be crucial for linkage across data sets, particularly across political jurisdictions

Lessons Learned

Methods and Tools

- ❑ As geocoding work is based on information such as census tract attributes, when a new census is conducted (e.g., 1990 to 2000), this information may change and hence, data geocoded in the latter part of the previous census may need to be updated (i.e., re-geocoded) once the new census information is released; this needs to be considered when planning geocoding work

Next Steps

- ❑ MDPH is completing the final statewide report linking TTHM and low birth weight
- ❑ MDPH is currently collecting water billing data for communities served by multiple PWS systems or where less than 95 percent of residents are served by a single PWS
- ❑ Establish metadata teams of data owners and users to better understand health and environmental data and identify ways for data owners to enhance their data for tracking without program resource impacts

Questions